NeoBiota 62: 509–523 (2020)
doi: 10.3897/neobiota.62.52623
http://neobiota.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
NeoBiota
Advancing research on alien species and biological invasions

Comparing the IUCN's EICAT and Red List to improve assessments of the impact of biological invasions

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Academic editor: S. Bacher | Received 27 March 2020 | Accepted 13 August 2020 | Published 15 October 2020

Citation: Van der Colff D, Kumschick S, Foden W, Wilson JRU (2020) Comparing the IUCN's EICAT and Red List to improve assessments of the impact of biological invasions. In: Wilson JR, Bacher S, Daehler CC, Groom QJ, Kumschick S, Lockwood JL, Robinson TB, Zengeya TA, Richardson DM (Eds) Frameworks used in Invasion Science. NeoBiota 62: 509–523. https://doi.org/10.3897/neobiota.62.52623

Abstract

The IUCN recommends the use of two distinct schemes to assess the impacts of biological invasions on biodiversity at the species level. The IUCN Red List of Threatened Species (Red List) categorises native species based on their risk of extinction. Such assessments evaluate the extent to which different pressures, including alien species, threaten native species. The much newer IUCN Environmental Impact Classification for Alien Taxa (EICAT) categorises alien species on the degree to which they have impacted native species. Conceptually, the schemes are related. One would expect that: 1) if a native species is assessed as threatened under the Red List due to the impacts of alien species, then at least one alien species involved should be classified as harmful under EICAT; and 2) if an alien species is assessed as harmful under EICAT, then at least one native species impacted should be assessed as threatened by alien species under the Red List. Here we test this by comparing the impacts of alien gastropods, assessed using EICAT, to the impact on native species as assessed based on the Red List. We found a weak positive correlation, but it is clear there is not a simple one-to-one relationship. We hypothesise that the relationship between EICAT and the Red List statuses will follow one of three forms: i) the EICAT status of an alien species is closely correlated to the Red List status of the impacted native species; ii) the alien species is classed as 'harmful' under EICAT, but it does not threaten the native species with extinction as per the Red List (for example, the impacted native species is still widespread or abundant despite significant negative impacts from the alien species); or iii) the native species is classified as threatened under the Red List regardless of the impacts of the alien species (threatened species are impacted by other pressures with alien species potentially

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a passenger and not a driver of change). We conclude that the two schemes are complementary rather than equivalent, and provide some recommendations for how categorisations and data can be used in concert.

Keywords
Aichi Target 9, documenting impacts, Gastropods, invasive alien species, invasion frameworks, species population declines, threatened species

Introduction

The role of biological invasion as a driver of global change (Vitousek 1994; UNEP 2011; Simberloff et al. 2013; Sage 2020) is recognised by the UN Convention on Biological Diversity (CBD) in its Strategic Plan for Biodiversity 2011–2020 (Aichi Target 9; see Essl et al. 2020 for a proposal of targets for 2030 and 2050) and the UN Sustainable Development Goals (SDG Target 15.8, IUCN 2016). Amongst the many negative impacts of biological invasions are their roles in species extinctions. Data from the IUCN Red List of Threatened Species (Red List), in particular, have been used to determine the impact of biological invasions as a threatening process (Bellard et al. 2016). However, the mechanisms through which biological invasions threaten species and the extent to which they place species on a trajectory towards extinction are not always clearly documented (Kumschick et al. 2015; Downey and Richardson 2016). The threat of alien species requires well-tailored tools for objectively documenting, monitoring, and reporting their impacts (Latombe et al. 2017). In response to the need to understand the impacts of alien species, the Environmental Impact Classification for Alien Taxa (EICAT) was developed by Blackburn et al. (2014) based on the structure of the Red List. Comprehensive guidelines for EICAT were subsequently developed by Hawkins et al. (2015) and, after various trials, wide-ranging consultation, and further developments of the scheme, EICAT was adopted as a standard of the International Union for Conservation of Nature (IUCN) in 2020 (IUCN 2020).

EICAT provides a simple, objective, and transparent tool for systematically documenting the impacts of alien species that occur anywhere in the world (IUCN 2020), thus facilitating the monitoring of SDG and CBD goals. The EICAT definition of alien species includes "all taxa moved intentionally or unintentionally by human activities beyond the limits of their native geographic range, or resulting from breeding or hybridisation and being released into an area in which they do not naturally occur" (IUCN 2020). EICAT enables the categorisation of alien species based on the magnitude of impacts on native species (Table 1). The magnitude of impact varies from a reduction in the performance of individuals to the loss of individuals, the loss of populations, the loss of species locally, and, in the worst case, to the global extinction of species (Hawkins et al. 2015; IUCN 2020). Alien species are then classified as harmful (reduction of population sizes or worse) or non-harmful (reduction in performance of individuals or no reduction) based on the highest recorded impact seen anywhere in the world. This will facilitate the comparison of alien species across regions and taxonomic groups, enable the tracking of invasion impacts over time, facilitate the prediction of impacts of alien species introduced

to new regions, and allow for the prediction of current impacts where such impacts have not yet been monitored, but have been recorded elsewhere in the world (Blackburn 2014; Hawkins et al. 2015; Latombe et al. 2017; Kumschick et al. 2020).

The Red List assigns species to categories of extinction risk using quantitative criteria and relevant species information, enabling species to be classed as threatened or not-threatened (IUCN 2019). As part of the process of assigning an extinction risk, the Red List identifies and documents the pressures on native species. These pressures include the five major biotic and abiotic pressures as defined by the CBD, namely invasive alien species, habitat loss and degradation, climate change, over-exploitation, and pollution (Global Biodiversity Outlook 2010). Information about the timing and nature of impacts [termed 'stresses' as per IUCN guidelines (IUCN 2019)] are recorded, as well as whether such impacts occur at the species or ecosystem-level (IUCN 2019). Pressures are also classified, where possible, by the scope (proportion of the population impacted) and severity (proportion of population decline over a set period) of impacts. The similarities and differences between the Red List and EICAT are outlined in Table 1.

In this paper, we examine the relationship between EICAT and the Red List using alien gastropods as a case study. We predict that: 1) if a native species is assessed as threatened under the Red List due to the impact of alien species, then at least one alien species involved should be classified as harmful under EICAT; and 2) if an alien species is assessed as harmful under EICAT, then at least one native species impacted should be assessed as threatened by alien species under the Red List. We then consider the relationship between the two schemes more broadly, responding to the World Conservation Congress (Hawaii 2016) resolution (WCC-2016-Res-018-EN) which urges the incorporation of EICAT assessment results into Red List assessments (IUCN 2016).

Methods

The choice of which taxa to use for comparison purposes was limited primarily by the availability of EICAT assessments (as a relatively new scheme, there are far fewer EICAT assessments than species with Red List assessments). EICAT assessments are available for alien birds (Evans et al. 2016), amphibians (Kumschick et al. 2018), and bamboos (Canavan et al. 2019), but we focussed on an assessment of 34 species of gastropods identified as alien species present in South Africa by Kesner and Kumschick (2018). The EICAT assessments by Kesner and Kumschick (2018), unlike the others, provide information on the specific impacted species and associated evidence sources. Moreover, the assessments looked at impacts anywhere in the world (the study aimed to identify potential impacts in South Africa). We used these assessments to create a database describing interactions between the alien gastropods and native species (only cases where the impacted native species was identified were included). This gave 192 records. We then excluded interactions where the alien species under EICAT, or the native species under the Red List, was scored as Data Deficient (DD) or Not Evaluated (NE). The final dataset consisted of 101 records of interactions [details of the full

Table 1. A summary of the IUCN Red List and the IUCN EICAT schemes showing areas of potential interaction between them. These are based largely on direct comparisons between the Red List guidelines (IUCN 2019) and EICAT standards and guidelines (IUCN 2020), see also Probert et al. (2020) for a discussion on uncertainty.

Sections	Red List	EICAT	Interaction between schemes
Purpose	To estimate the risk of extinction of specific native species and the drivers contributing to this risk.	To identify the type and magnitude of impacts that specific alien species have on native species.	The schemes have different purposes but share some outputs, for example, documenting alien species impacts.
Scheme categories	Not Evaluated (NE) Data Deficient (DD) **Not-threatened** Least Concerned (LC) Near Threatened (NT) **Threatened** Vulnerable (VU) Endangered (EN) Critically Endangered (CR) **Extinct** Extinct in the Wild (EW) Extinct (EX)	Not Evaluated (NE) No Alien Populations (NA) Data Deficient (DD) **Non-Harmful** Minor (MN) Minimal Concern (MC) **Harmful** Moderate (MO) Major (MR) Massive (MV)	With increasing threat levels of the impacted species on the Red List, the impact severity of the alien may also increase on EICAT. This may not be true for all cases.
Geographical scope	Global, regional or national.	Global, regional or national.	For the Red List, the global population is the entire distribution of the species within its native range. All levels of assessment are related to the global population (e.g., regional adjustments). For EICAT, the global scope refers to impacts recorded where there are alien populations present, and impacts are not related to the global population of the impacted native species.
Population declines	Population decline is recorded against specific thresholds per category. It is also assessed across different time frames (past, present, and future).	Harmful categories indicate decline, MO is for a population; MR is a reversible loss of a population; MV is an irreversible loss of a population. Only past declines are considered.	There are different thresholds of decline and methods and time frames of recording population decline.
Which species are explicitly specified	Native species and the species causing impacts (e.g., alien species, unless the native species is LC).	Alien species and native species being impacted.	Need to identify the same impacted taxa to enable the linkage of schemes.
Evidence sources	Projected, inferred, estimated or suspected.	Observed (estimated) and inferred.	The Red List makes allowance for the use of projections and suspected evidence, while these are not included on EICAT. Data included in Red List assessments may not be accepted under EICAT.
Responsiveness of schemes	Assessments are due every 10 years or as resources and/or new information becomes available. Additionally, new species are described regularly, so there are always more assessments to be conducted.	As a new scheme, only few groups have been assessed. Additionally, impacts must have been recorded before an assessment can be conducted or the species will be assessed DD or NE.	Two sources of delays in detecting change. First is due to processes of the assessment schemes (e.g. resource availability, expert time, assessment information). Second is the role of invasion debt resulting in, for example, delay in the detection of impacts.
Taxonomy	An updated taxonomic backbone is used, but is dependent on the experts to prompt updates.	Uses the same taxonomic backbone as the Red List; however, primary references may include outdated taxonomy of alien and impacted native species.	Both schemes are in principle using the same taxonomic backbone; however, primary literature sources may differ. This is a procedural difference and will need management as assessments are conducted.
Final status selection	The highest threat status selected based on supporting data as a precautionary method.	The highest impact status selected corresponding to the maximum threat level.	Both schemes make use of the highest status obtained.
Measure of uncertainty	No specific categories. Specify best estimate or range of plausible values and document all information used and process of calculation.	Three different levels: high, medium, and low.	Not directly comparable. Primary literature needs to be examined to determine how the uncertainties relate.
Sources of uncertainty	Natural variability and semantic uncertainty (vagueness in terms and definitions used in the criteria).	Presence of confounding effects, study design, data quality and type, spatial and temporal scale, and coherence of evidence.	Not directly comparable. Primary literature needs to be examined to determine how the uncertainties relate.
Threshold bases	Quantitative (e.g. range size, number of individuals).	Qualitative (e.g. categories of decline from individual performance to populations and species).	Not applicable.

range of individual impacts taken from Kesner and Kumschick (2018)], with information on the risk of extinction, year of assessment, population trend, and stresses (attributes of a taxon that are impaired due to the impacts of a pressure) taken from the Red List (IUCN 2019).

Given that the data are categorical, we used a Pearson Chi-squared test to assess, across all species interactions, whether harmful or non-harmful alien species tended to be associated with threatened or not-threatened native species (see Table 1 for details of the scheme categories). A Monte Carlo simulation was used with 1000 replicates, as the frequency of one of the variables was less than 5 (Hope 1968). We then compared EICAT statuses in order of increasing magnitude of impact (MC < MN < MO < MR < MV) to Red List statuses with increasing level of extinction risk (LC < NT < VU < EN < CR < EW or EX) using logistic ordered regression implemented in the R package polr (R Core Team 2019), with EICAT status as the predictor variable.

Results

Most impact evidence was recorded in Australia (n = 48), Hawaii (n = 12), and New Zealand (n = 10). The publication dates of the impact studies ranged from 1976 to 2016. All threatened species that were impacted had small distribution ranges and were endemic to the Hawaiian Islands, except for the fountain darter *Etheostoma fonticola* (EN), which is restricted to two locations in central Texas (extent of occurrence less than 100 km^2) (NatureServe 2013).

Of the 101 interaction records, only 18 had harmful EICAT statuses (17 Moderate impacts and one Major). This is not surprising as few alien species cause severe negative impacts and biological invasions is one of several interacting threats (Simberloff 2011; Hulme 2012; Russell 2012). Similarly, only a few of the interactions (13) were on threatened native species. However, almost all (10) of the threatened native species were impacted by harmful alien species. The majority of alien species assessed as having a Minor impact (MN) were impacting native species that were of least concern of extinction (LC), with one exception, the impacted native species, Po'ouli (*Melamprosops phaeosoma*), which was listed as Extinct (EX) (BirdLife 2019). There were only seven interactions where the same impacting alien species or group of species were identified in both schemes. In these seven interactions, the same mechanism of impact was scored in both schemes for the majority of interactions. Evidence for a large number of interactions was from laboratory experiments (n = 58). These interactions are scored as non-harmful under EICAT as per EICAT guidelines for evidence from laboratory experiments.

Harmful alien species tended to be associated with threatened native species, and non-harmful alien species with not-threatened species (chi-squared value = 35.6, $P < 0.001$). Similarly, an increase in Red List status was associated with an increase in the EICAT status (LR test = 28.0, df = 3, $P < 0.05$), although none of the individual transitions was significant (e.g. MO–MR or EN–CR), probably due to the low sample sizes (Fig. 1).

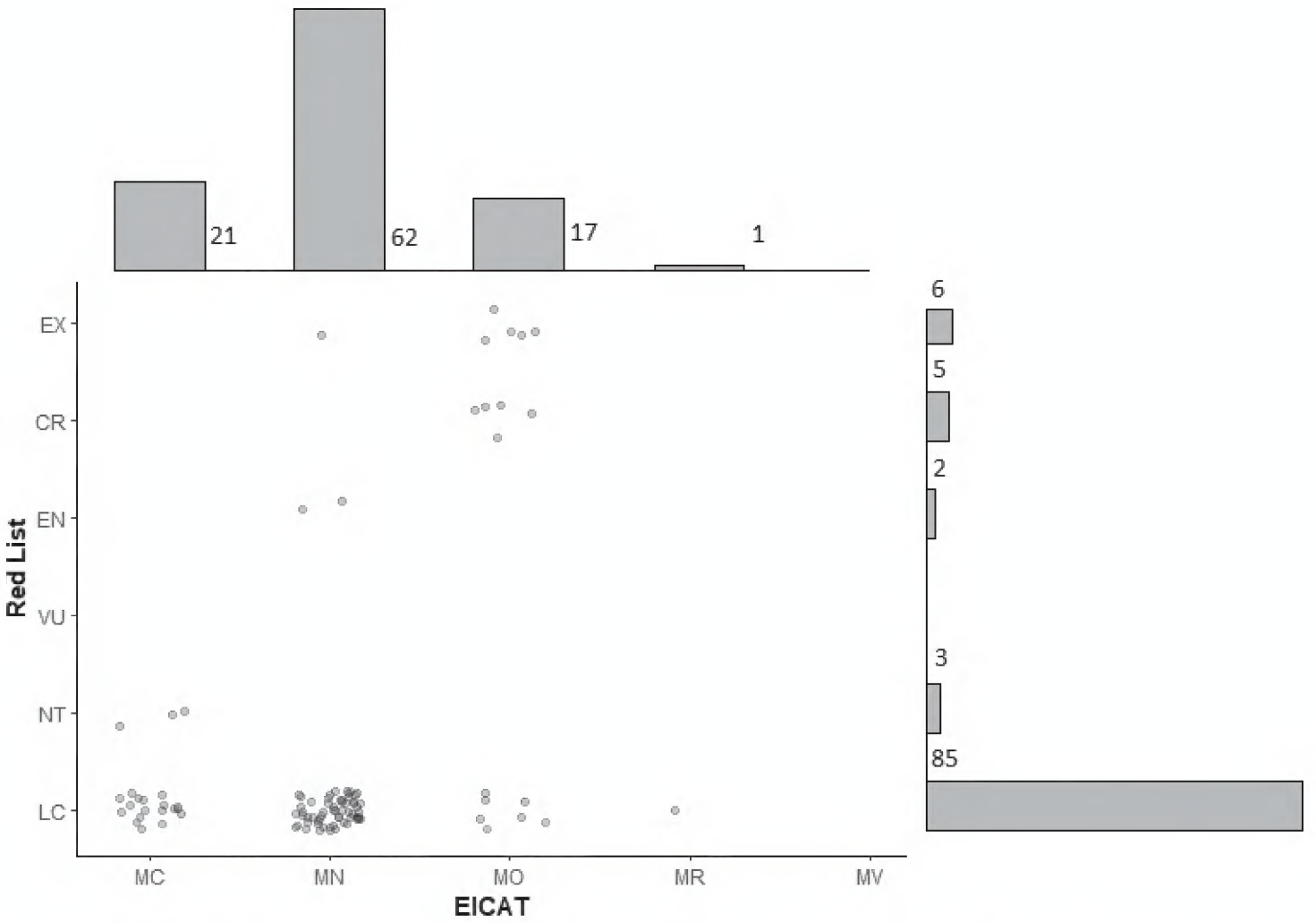

Figure 1. The relationship between EICAT and Red List assessments for interactions between alien gastropods and native species that were recorded as impacted (n = 102). In order of increasing impact, the EICAT categories are: Minimal Concern (MC), Minor (MN), Moderate (MO), Major (MR), and Massive (MV). In order of increasing extinction risk, the Red List categories are: Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), and Extinct (EX). Extinct in the Wild is included in the EX category. Points are jittered to avoid overplotting. Margin bars indicate the numbers of interactions per Red List and EICAT category. The EICAT scores are based on the study by Kesner and Kumschick (2018), who assessed the global impacts of 34 gastropod species present as alien to South Africa.

Discussion

We found a positive but weak correlation between the EICAT status of alien species and the Red List status of impacted native species. However, the relationship between the two schemes is not a simple one-to-one correlation. We hypothesise that the relationship between Red List and EICAT statuses will follow one of three general forms.

Firstly, a linear relationship will occur when there is a positive correlation between the EICAT status of an alien species and the Red List status of an impacted native species (general form i in Fig. 2). Based on the analysis on alien gastropods, the schemes will align when: 1) they identify the same native species as impacted by the same alien species; 2) there is documented evidence of impact in at least one of the schemes; 3) the impacted native species has a small distribution range; and 4) the impacted native species shows a population decline that is caused by the alien species. However, a native species might not be threatened under the Red List regardless of the severity of the impact under EICAT (general form ii on Fig. 2). If a native species is widespread and abundant, then there might be large and significant negative impacts from alien species, but such

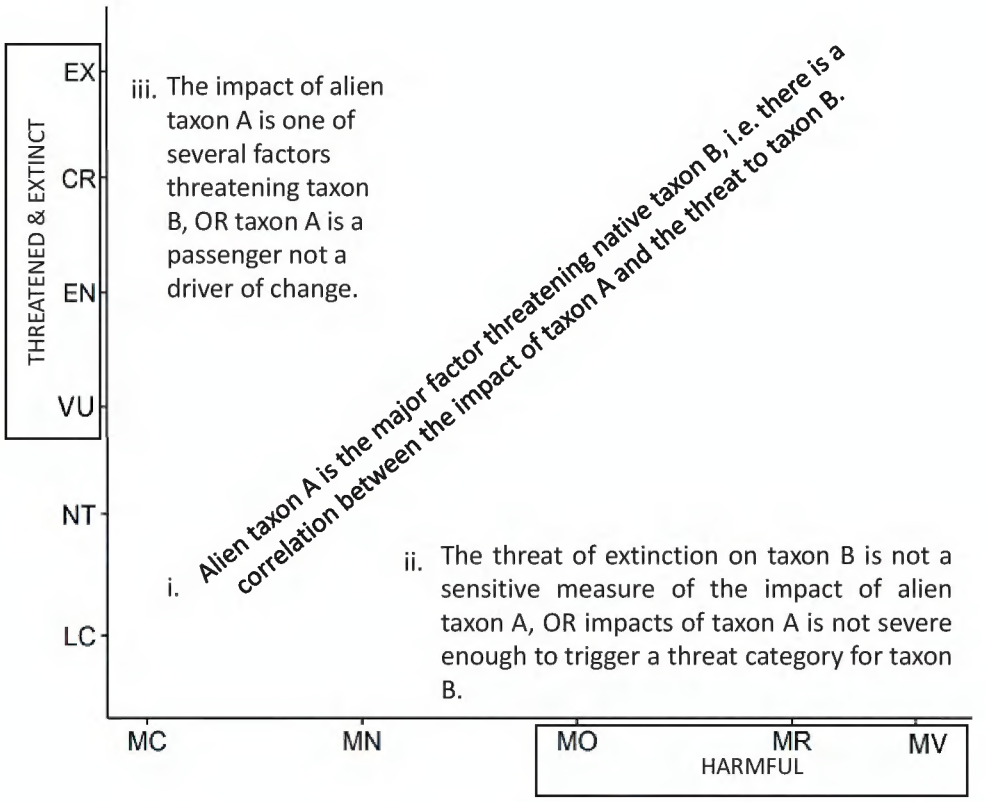
THREATENED & EXTINCT
EX
CR
EN
VU
NT
LC
iii. The impact of alien taxon A is one of several factors threatening taxon B, OR taxon A is a passenger not a driver of change.
Alien taxon A is the major factor threatening native taxon B, i.e. there is a correlation between the impact of taxon A and the threat to taxon B.
i.
ii. The threat of extinction on taxon B is not a sensitive measure of the impact of alien taxon A, OR impacts of taxon A is not severe enough to trigger a threat category for taxon B.
MC
MN
MO
MR
MV
HARMFUL

Figure 2. The proposed three forms of the relationship between assessments using the EICAT and the Red List schemes.

impacts do not threaten the native species with extinction. Finally, native species might experience various levels of threat despite there being little, if any, impact from an alien species (general form iii on Fig. 2). Native species are threatened by multiple interacting threats, of which alien species is but one. In particular, alien species can respond as a "passenger" to other drivers of change that directly threaten native species with extinction (MacDougall and Turkington 2005), for example, habitat transformation.

The different forms of the relationship arise, we argue, due to structural differences between the Red List and EICAT. Specifically, the schemes differ in the geographic coverage of assessments, the type of evidence used in assessments, their responsiveness to change, the mechanisms of impact, the specification of the alien species causing the impact, and the approach to taxonomic changes. We discuss these in turn.

Geographical coverage of assessments

Both assessment schemes have a global scope, but how underlying assessment data are interpreted is very different. EICAT assessments make use of all known impacts of an alien within its introduced range(s). However, impacts are recorded at the scale of a specific subpopulation or locality and the impacts often relate to only part of the global population of the impacted native species (Volery et al 2020). By contrast, for all levels of assessment on the Red List (national, regional, and global), the measured impacts and the resulting population declines are related to the entire global native population of the assessed species (e.g., regional adjustments, see IUCN guidelines, IUCN 2019).

The final Red List status of the species is adjusted when related to the global population if assessments are below the global scope. This has two consequences.

First, there is likely to be a closer correlation between EICAT and the Red List for alien species that impact native species that are range-restricted. For example, *Cyanea grimesiana* is an island endemic plant assessed as Critically Endangered (CR) in 2015, with biological invasion listed as a major pressure (Keir 2015). This species has a very restricted native range, an extremely small population (it is only known from 16 individuals), and is experiencing population decline (Keir 2015). Herbivory by two alien slug species, *Limax maximus* and *Limacus flavus*, is one of the pressures on *C. grimesiana*, and the evidence is that *L. maximus* and *L. flavus* are having a Moderate (MO) impact as per EICAT (Kesner and Kumschick 2018). In this case, the impact will likely be directly correlated to the threat status.

Second, native species that are widespread and assessed as of Least Concern (LC) in the Red List can be impacted by alien species with a wide range of EICAT statuses. This can be due to the range of scales at which impacts are recorded in EICAT and/or higher impacts relative to the local populations, not global ones, as in the Red List [e.g. Major (MR) impacts are described as reversible local population extinction]. An alternative explanation is that the native species might have a large global population, and a decline in the local populations is not sufficient to trigger a threatened category on the Red List. For example, the attenuate fossaria snail (*Galba truncatula*) is widespread across southwest Asia, southern Europe, and Mediterranean North Africa, and is predated upon by Draparnaud's glass snail (*Oxychilus draparnaudi*) (Rondelaud 1977). The attenuate fossaria snail was assessed as Least Concern (LC) on the Red List and there are no recorded declines or threats to this species (Seddon et al. 2014). Nonetheless, the alien Draparnaud's glass snail is still recorded to have Major (MR) impact, given its impacts on particular native populations of the attenuate fossaria snail (Kesner and Kumschick 2018).

Even though the native species was not threatened overall, such impact information is valuable for inclusion in a Red List assessment. It can become useful, for example, if the widespread species becomes threatened and can be used as evidence to track impacts over time. Additionally, this information can be used to highlight potential future threats to a species, even if it is currently not threatened (IUCN 2019). When including this information in the Red List the threat score would most likely be low, with severity classified as negligible. However, an assessor can also decide on the impact score by considering the primary source of the EICAT assessment, particularly the date of assessment and the type of evidence. This information can be used to determine the timing, severity, and scope of the impact, which determine the threat score in the Red List. Similarly, data collected on impacts of aliens identified in the Red List without an EICAT assessment could be used as a starting point for the EICAT assessment.

Type of evidence used in assessments

Despite our expectations, the schemes did not consistently draw from the same evidence sources in our case study on gastropods. This was partly an issue of timing (see

responsiveness to change below), but the schemes also differ in the types of evidence considered. The Red List includes evidence that is observed, estimated, projected, inferred or suspected (IUCN 2019). When conducting Red List assessments, detailed data are not always available across the entire global range of a species, but the Red List allows the use of different data sources, enabling assessments to be conducted in the absence of complete data (IUCN 2019). For EICAT, only observed and inferred evidence from the introduced range of alien species may be included, while projected and suspected sources are excluded (IUCN 2020). The type of evidence EICAT uses is strongly linked to its purpose, providing a systematic method of collating evidence of the impact of alien species in their introduced range. In this study, the Red List evidence was based mostly on expert observations. Moreover, 58 of the interactions were based on laboratory experiments on EICAT. These were assessed as Minor (MN) or of Minimal Concern (MC). All EICAT assessed interactions classified as harmful were based on evidence sources from field experiments in this study as the protocol for EICAT states that declines due to alien species impact as measured by laboratory experiments cannot be considered as of Moderate (MO), Major (MR) or Massive (MV) impact (Table 1).

Responsiveness to change

Given the two systems are currently independent, updates of assessments might happen at different times and so scores may diverge. For example, Pua ʻala (*Brighamia rockii*), a Critically Endangered (CR) plant species, is only known from three subpopulations within the Hawaiian Islands and is currently experiencing population declines (Bruegmann and Caraway 2003). A study by Joe (2006) found that populations of *B. rockii* were impacted by *Limacus flavus* (the alien cellar slug). Therefore, *L. flavus* was assigned an impact status of Moderate (MO) under EICAT in Kesner and Kumschick (2018). However, the Red List assessment for *B. rockii* was published in 2003 and did not (or rather could not) incorporate the findings of Joe (2006): *L. flavus* was not mentioned in the Red List assessment as a pressure. The collection dates of primary source data on EICAT and the Red List are crucial. If this information is available, it can be used to resolve discrepancies between the schemes or even potentially determine the timing of the threat (IUCN 2019).

Under both schemes, there will be time lags between impacts occurring, the recording of impacts, and the incorporation of such data into assessments (IUCN 2019; IUCN 2020). Neither scheme deals explicitly with such lagged biodiversity responses (Crooks 2005; Essl et al. 2015) or, more specifically, invasion debt (Rouget et al. 2016). However, the schemes also differ in how they respond to new information. EICAT assessments can be easily updated on the publication of a single impact report. The Red List, on the other hand, does not require information to be formally published before it can be incorporated into an assessment, and can incorporate observed information, as well as projected and suspected evidence. This reduces the need to wait for evidence to be collected and reported before assessment (IUCN 2019; IUCN 2020). However,

the Red List is dependent on experts' time and resource availability to finalise assessments, so updates may take longer.

Moreover, the status of a species on the Red List can improve or deteriorate from assessment to assessment (IUCN 2019). For EICAT, however, the impact status of alien species can only ever be up-listed to a more severe impact level. Thus, even if an alien species is no longer threatening a particular native species, it can still be categorised as harmful due to past impacts recorded (IUCN 2020). Therefore, the two schemes should exchange data with care. Coding the timing of the impacts would support this process; the Red List records this information and this should also be the case for EICAT (IUCN 2019).

Mechanisms of impact

Classification of the mechanisms of impact is similar between the schemes, but there are some key differences (Fig. 3). The underlying information and evidence used in the assessments must, therefore, be examined if the mechanisms are to be compared. For example, chemical, structural or physical ecosystem impacts recorded on EICAT could potentially be linked to either ecosystem conversion or ecosystem degradation on the Red List. Understanding the mechanisms of impact between the systems will assist in understanding the impact magnitude when linking the schemes.

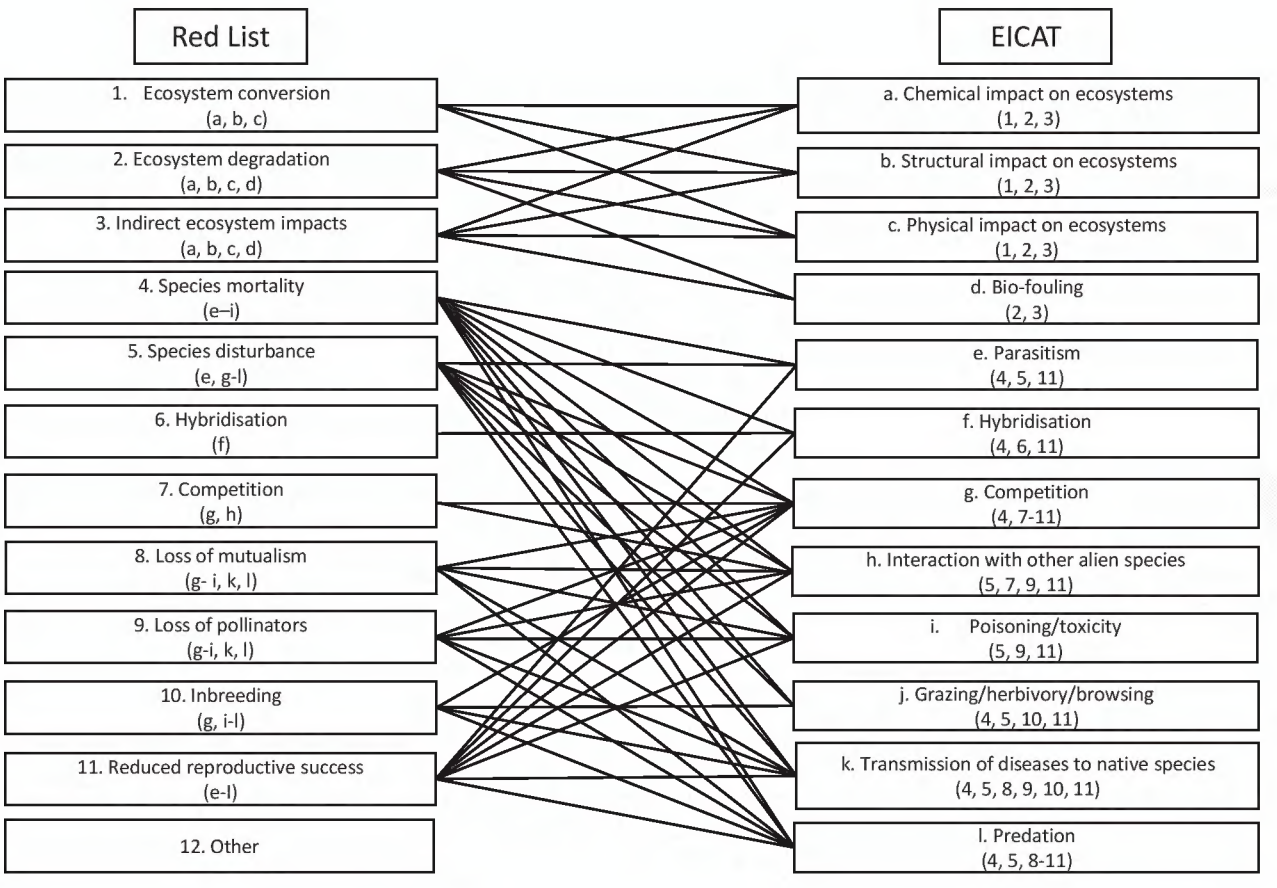
Red List
1. Ecosystem conversion (a, b, c)
2. Ecosystem degradation (a, b, c, d)
3. Indirect ecosystem impacts (a, b, c, d)
4. Species mortality (e–i)
5. Species disturbance (e, g-l)
6. Hybridisation (f)
7. Competition (g, h)
8. Loss of mutualism (g- i, k, l)
9. Loss of pollinators (g-i, k, l)
10. Inbreeding (g, i-l)
11. Reduced reproductive success (e-l)
12. Other
EICAT
a. Chemical impact on ecosystems (1, 2, 3)
b. Structural impact on ecosystems (1, 2, 3)
c. Physical impact on ecosystems (1, 2, 3)
d. Bio-fouling (2, 3)
e. Parasitism (4, 5, 11)
f. Hybridisation (4, 6, 11)
g. Competition (4, 7-11)
h. Interaction with other alien species (5, 7, 9, 11)
i. Poisoning/toxicity (5, 9, 11)
j. Grazing/herbivory/browsing (4, 5, 10, 11)
k. Transmission of diseases to native species (4, 5, 8, 9, 10, 11)
l. Predation (4, 5, 8-11)

Figure 3. Proposed links between the mechanisms by which alien species impact native species as identified under the Red List and EICAT schemes. The description of each mechanism has been modified slightly to align the two schemes.

Specification of the alien species causing the impact

As part of an EICAT assessment, impacted native species are identified, and supporting documentation is recorded. By contrast, in the Red List, the alien species affecting native species are only required to be identified and recorded if the native species are assessed as threatened or Near Threatened (NT). For other classifications this information is optional.

Both schemes allow for the impacting species to be identified at whatever taxonomic level is appropriate or available. If a specific alien species is not identified in the assessment (e.g., only as a "slug" rather than as *L. flavus*), then further information is needed to improve the assessment. In this study, we found seven interactions for which the same alien species or groups of species were identified in both schemes. The majority of these assessments were for threatened species, with the exception of a single native species that was categorised as of Least Concern (LC) (Kesner and Kumschick 2018). The Red List assessment of this native species (*Lymnaea natalensis*) identified a congeneric alien species (*Lymnaea columella*) as having a minor impact scope, similar to its EICAT status of Minor (MN) (Kesner and Kumschcik 2018). We would strongly encourage the specification of impacting aliens, even for native species that are of Least Concern (LC), and that consideration is given to appropriately scoring their impact levels (Albrecht et al. 2018b).

Approach to taxonomic changes

The Red List's taxonomy is updated regularly when new classifications become available and when prompted by experts. EICAT refers to the Red List for taxonomy. However, the taxonomy used in primary references can differ. This may be particularly relevant for species with many synonyms that result from different taxonomic revisions. Information on synonyms captured in the Red List helps maintain this link, though the situation can be complicated. For example, *Bulinus natalensis* is part of a species complex that is widespread across Africa. It was assessed as Least Concern (LC) on the Red List under the currently-accepted name *Bulinus truncatus* (Albrecht et al. 2018a). Before *B. natalensis* was included in the species complex, it was recorded to have a small range size (de Kock and Wolmarans 2006), and, if pressures impacted it, then it might have been assessed as threatened in the Red List. This illustrates how changes in the taxonomy can influence the Red List status of a species and potentially an aliens species' EICAT status.

Conclusions and recommendations

The EICAT and Red List schemes will benefit each other if information underpinning their assessments is made available and shared. Making such supporting information available in appropriate formats will improve the generation of sound evidence-based assessments, and help to identify data gaps and research needs. For example, alien

species noted to cause impacts under the Red List which are assessed on EICAT as Data Deficient (DD) or are Not Evaluated (NE) should be prioritised for further research and EICAT evaluation (and vice versa).

Each scheme should link to relevant corresponding data in the other. The Red List uses a well-organised data management platform, the Species Information System (SIS), to gather, organise, and store data. The development and use of a similar data management platform for EICAT would aid assessments and could be tailored to enable data exchange between the two schemes. Our study shows that the types, extent, and frequency of information overlap between the two schemes depend on a range of factors, including geographical scope, population trends, evidence sources, scheme responsiveness, mechanisms of impact, and the taxonomic systems used. Further, as assessments under either scheme are updated, corresponding assessments need to be examined and potentially revisited.

In summary, while the Red List and EICAT are conceptually related, they have different purposes and methods. We are keen to see similar evaluations for other taxonomic groups and habitats, but we predict that the results will be similar to those outlined in Fig. 2. EICAT and the Red List will not always align, nor should they. This means that while the EICAT and Red List schemes might be complementary and information can and should be shared between the schemes, they are not interchangeable.

Acknowledgements

We thank Avril Castelle Subramoney for collecting information on impacted species from the Kesner and Kumschick (2018) gastropod dataset; Domitilla Raimondo for reviewing an earlier version of this manuscript and for providing valuable comments; and comments from a anonymous reviewer, Kevin Smith, Philip Hulme, and the handling editor that helped us improve the manuscript tremendously. This paper emerged from a workshop on 'Frameworks used in Invasion Science' hosted by the DSI-NRF Centre of Excellence for Invasion Biology in Stellenbosch, South Africa, 11–13 November 2019, that was supported by the National Research Foundation of South Africa and Stellenbosch University. DVDC, JRUW, and SK acknowledge the support of the DSI-NRF Centre of Excellence for Invasion Biology (CIB) and Stellenbosch University, and the South African Department of Forestry, Fisheries and the Environment (DFFtE), noting that this publication does not necessarily represent the views or opinions of DFFtE or its employees.

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